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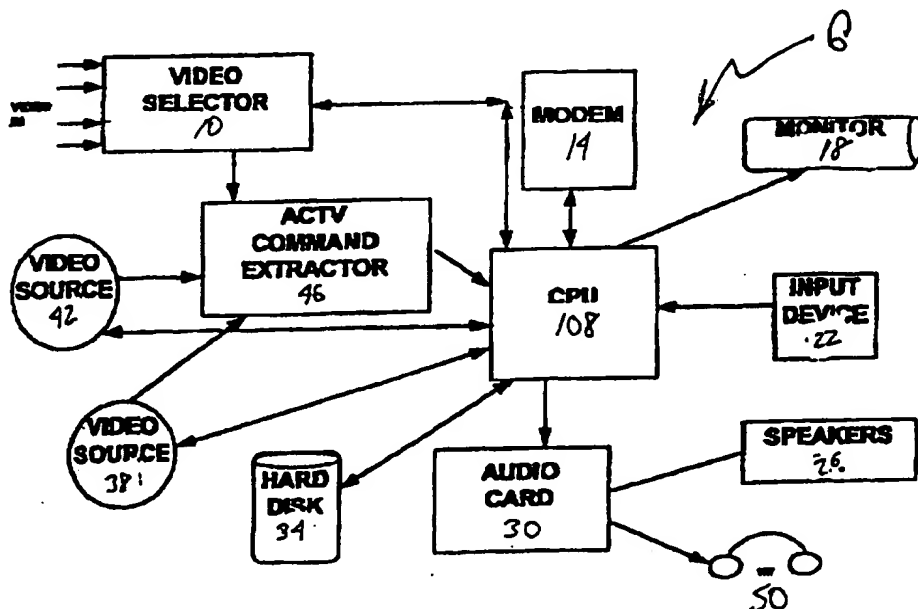
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(57) Abstract

A computer based interactive system branches among a variety of inputs from a variety of different sources (30, 38, 42) during the same interactive session. This interactive system integrates switching (10) of full-motion video, graphics and audio from various sources simultaneously during the show.

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# SYSTEM FOR PROVIDING AN INTERACTIVE PRESENTATION

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### RELATED APPLICATIONS

This is a continuation-in-part of application Serial No. 08/443,607, filed May 18, 1995, which is continuation-in-part of application serial no. 08/166,608, filed December 13, 1993 which in turn is a continuation of application serial no. 07/797,298, filed November 25, 1991, now abandoned. The interactive television program is of a type disclosed in commonly copending U.S. Patent Application Serial No. 08/289,499, filed August 12, 1994, and in U.S. Patent Nos. 4,847,700, 4,507,680, 4,573,072, 3,947,792, 4,602,279, 4,264,925, and 4,264,924.

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### BACKGROUND OF THE INVENTION

Interactive video and audio presentation systems are currently being introduced into the entertainment and educational industries. A prominent interactive technology that has been applied successfully in these industries is based on providing interactivity in a one-way system through the provision of multiple parallel channels of information. For example, commonly owned Freeman et al. patents, U.S. patent nos. 4,264,925 and 4,264,924, which provide both audio and video interactivity, disclose interactive television systems where switching among multiple broadcast or cable channels based on viewer selections provides an interactive capability.

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These systems have been enhanced to include memory functions using computer logic and memory, where selection of system responses played to the

viewer are based on the processing and storage of subscriber responses, as disclosed in Freeman patent, U.S. patent no. 4,507,680.

The benefits of providing interactivity through the use of different audio responses is disclosed in Freeman, U.S. patent nos. 4,847,698, 4,847,699  
5 and 4,847,700. These television systems provide a common video signal accompanied by several synchronized audio channels to provide content related user selectable responses. The audio signals produce different audio responses, and in some cases, these are syllable synched to a first audio script and to the video signal (such as to a person or character on a display),  
10 providing the perception that the person's or character's mouth movements match the spoken words.

Interactivity is brought to the classroom in the Freeman U.S. patent application serial no. 08/228,355. The distance learning system claimed in this application enhances the classroom educational experience through an  
15 innovative use of interactive technology over transmission independent media. When an instructor, either broadcast live on video or displayed from videotape, asks a question, each and every student responds, preferably by entering a response on a remote handset, and each student immediately receives a distinct and substantive audio response to his or her unique  
20 selection. The individualization of audio response from the interactive program is a major aspect of the invention.

Individualization of audio is brought to the home based on the technology disclosed in Freeman U.S. patent application serial no.

08/228,355. This system provides a program that can be watched on any conventional television set or multimedia computer as a normal program. But if the viewer has a special interactive program box connected to the television, he or she can experience a fully functional interactive program.

5 Each interactive viewer enjoys personalized audio responses and video graphics overlayed on the screen. The interactive program can be provided to television sets or to computers by cable, direct broadcast satellite, television broadcast or other transmission means, and can be analog or digital. Unlike previous interactive systems, this application covers a system that subtly  
10 introduces the interactive responses to the viewer throughout the program. This enhanced interactivity is provided through the use of "trigger points" spread throughout the program. Trigger points occur at designated times and result in the program content being altered to present individual attention to the particular viewer.

15 However, what is needed is an interactive personalization provided via an interactive multimedia computer. Furthermore, a system is needed that provides not only the ability to branch amongst parallel transmitted datastreams, but also, the capability to seamlessly integrate input from other media, such as CD-ROMs and laser disks, into the presentation. What is  
20 needed is a computer-based system for branching between a variety of inputs during the same interactive session including full-motion video, computer graphics, digital video overlays and audio.

### SUMMARY OF THE INVENTION

The ACTV system is based upon branches which occur in the course of the full-motion video. Branches may be to other full-motion video segments, to graphics which are integrated into the video, and/or to audio segments  
5 which are integrated into the show.

Sometimes, the ACTV system will act upon the user's response immediately; other times, it will utilize ACTV's unique "trigger point" concept to act upon the response later. ACTV's technology enables the computer to "remember" the user's responses and integrate them into the video and audio  
10 at a later point. Regardless of whether the action is taken as a result of the user's response immediately or later, it is done seamlessly.

ACTV's television technology provides the capability to seamlessly branch among multiple video and audio sources. ACTV's computer technology provides the ability to seamlessly branch not only among the  
15 multiple video and audio channels, but also to seamlessly integrate input from other media, such as CD-ROM's, laser disks, hard disks, and remote servers, connected via the Internet or another network, into the show.

During a television-based ACTV interactive session, the system will branch among either multiple television channels or multiple audio sources, depending upon the type of implementation. By contrast, during a computer-  
20 based interactive session, branches may be among a variety of inputs from a variety of different sources during the same interactive session: full-motion video, computer graphics and audio. Since the computer provides the

capability to process data from various multimedia inputs simultaneously, ACTV technology can integrate seamless switching of full-motion video, graphics and audio from various sources simultaneously during the show. The computer-based ACTV implementation is therefore much more flexible  
5 than the television-based ACTV implementation.

It also provides the user with the capability to interact with the show utilizing a variety of input devices. Not only can the user interact with the show by pressing a multiple-choice button, but the interaction can also take the form of entry via the range of multi-sensory devices available on the  
10 computer, including mouse entry, full-motion pen entry and touch screens. This integration of various input and storage devices is particularly valuable in an educational environment, since it provides students with the ability to participate in their lessons in a variety of ways. The computer can both store the interactions for future reference and also transmit them to the teacher, via  
15 either a computer network or, in a distance learning setting, via a telephone network.

An ACTV interactive session can integrate full-motion video with user input at the same time. For example, the full-motion video may be playing on the screen, while the user is drawing a diagram in a corner of the screen. Thus,  
20 the video and audio may provide real-time input which the user is applying during the session on the same computer monitor.

### DESCRIPTION OF THE DRAWINGS

Figure 1 is a diagram of an interactive computer workstation, receiving inputs from television broadcasts and/or local storage devices.

5 Figure 2 is a diagram of an interactive computer workstation which receives its input primarily from television broadcasts.

Figure 3 is a diagram of an interactive computer workstation which receives its interactive programs entirely from local storage, rather than television broadcasts.

10 Figure 4 is a diagram of an interactive network for interactive processing.

Figure 5 is a diagram of an interactive computer system, receiving inputs from a multichannel cable transmission and showing outputs via a conventional television monitor.

15 Figure 6 is a block diagram of one interactive computer workstation embodiment to achieve seamless switching between video signals.

Figure 7 is a block diagram showing an alternative interactive computer work station embodiment to achieve seamless switching between video signals.

20 Figure 8 is a block diagram showing another alternative to achieve seamless switching between video signals.

Figure 9 is a time diagram showing a representation of trigger points and corresponding alternative audio, video or graphics segments, one of which is

selected for presentation to the subscriber immediately after the execution of a trigger point function.

Figure 10 is a diagram of an interactive computer work station embodiment for branching amongst multiple audio segments in a single video channel embodiment, where the interactive audio and data elements are  
5 embedded in the video channel.

Figure 11 is a diagram of a second interactive computer work station embodiment for branching amongst multiple audio segments in a single video channel embodiment, where the interactive audio segments are sent in the  
10 SAP audio channel.

Figure 12 is a diagram of a third interactive computer work station embodiment for branching amongst multiple audio segments in a single video channel embodiment, where two tuners are employed; the first tuner for tuning to and demodulating the standard video and audio signal and the  
15 second of which is for demodulating a secondary analog carrier comprising modulated serial digital audio segments.

Figure 13 is a diagram of a fourth interactive computer work station embodiment for branching amongst multiple audio segments in a single video channel embodiment, also comprising two tuners, but with a digital  
20 demultiplexer configuration for demultiplexing the digital audio stream into n parallel digital audio channels, wherein the n parallel digital audio channels are time division multiplexed at the head-end and transmitted as a separate digital audio stream.

### PREFERRED EMBODIMENT

As shown in Figure 1, the present invention is a computer based system for receiving a fully interactive program, allowing subscribers to interact with the program through the use of a keypad and personal computer.

Alternatively, the multiple video/audio datastreams may be received from a broadcast transmission source or may be resident in local or external storage including CD ROM, video datatape, etc., as discussed below.

The interactive computer, 6 uses an interactive program delivery system with any transmission means including satellite, cable, wire or television broadcast to deliver the interactive program (hereinafter "composite interactive program") from a centralized location, or operations center, for distribution to subscribers in their homes. The program may be broadcast live from the operations center. For example, live sporting events with added interactive elements can be broadcast from the operations center. Such live interactive elements could be different camera angles, slow motion video, etc. Alternatively, the program can be produced off-line and stored in a program storage means at the operations center. Furthermore, the program can be produced and stored locally at the remote site on CD ROM or some other transferrable storage device such as digital or audio videotape, or laser disk.

An interactive presentation can comprise branching amongst full motion video, computer graphics and audio, with the interactive elements either received over a transmission media or stored locally, or both, all within

the same show. As shown in Figure 1, the workstation can branch among video segments from television broadcasts, local video servers 38, 42 (such as CD-ROMs, laser disks and tape players), still images and audio segments from the preceding media, as well as those stored digitally on hard disks 34, and  
5 segments obtained over networks such as the Internet.

The present invention, as shown in Figure 1, is a system for processing on a computer a fully interactive program allowing users to interact with the program through a computer input device 22 connected to a standard computer system 6, comprising a CPU 108, hard disk 34, audio card 30 and  
10 monitor 18. The interactive multimedia computer 6 resides in the home of the subscriber or elsewhere, such as at a cable headend, as described below. If at the home, the interactive computer, 6 is usually located near the subscribers' television, if connected to the television set. Preferably, any of the multimedia computer embodiments, discussed below, comprise a video demodulator  
15 board, a keypad for entering subscriber selections, a data extractor board 46 (for extracting data from the vertical blanking interval from the video signal(s), temporary and permanent data storage, a modem 14, and a processor 108.

Broadcast television is received by the video selector 10, which selects among various television channels to capture a video signal to be displayed on  
20 the computer monitor 18. Multiple television channels may be received. Figure 2 shows an interactive computer workstation configuration which receives its input primarily from television broadcasts. With the technology of

the present invention, seamless branching is provided among these television channels.

In the preferred embodiment, interactive programming is also stored on Video Source devices 38, 42, as shown in Figures 1 and 3. The Video Sources  
5 38, 42 may be any local storage device which is accessible by the computer, including CD-ROMs, laser disks, VCR's and tape players. While Figures 1 and 3 show only two video sources, there may be any number of such devices.

When CD-ROM 54 is employed in the present invention, it is a component of a unique interactive experience. The present invention utilizes  
10 CD-ROM 54 as one of the multiple input devices. Since branching is always seamless in the preferred embodiment, the computer 6 may receive input from at least two devices, regardless of whether these sources are random access. This is necessary to avoid delays during search periods. While one device is playing the video, the other searches for a new branch. When the second  
15 device finds the segment for output display, the other input device searches for a new branch. When the second device finds the segment to be shown, the branch occurs seamlessly. The apparatus and method for seamless branching among various video signals is described in the paragraphs below.

Segments of the interactive program may also be stored on the  
20 computer's hard disk 34. The segments stored on the hard disk, 34 are usually computer graphics, still images or audio segments, which are integrated into the presentation. The format for storage on the hard disk 34 is digital. Any

storage device may, however, store any combination of full-motion video, still images, graphics and audio segments.

As shown in Figures 1-3, the interactive commands are extracted from the program by the Command Extractor 46. Alternatively, these commands  
5 may be stored on an auxiliary storage device such as the hard disk 34.

The commands are processed by the computer's Central Processing Unit (CPU) 108, shown in Figures 1-3. The computer may be an IBM Personal Computer (PC) – Compatible, an Apple computer or any other type of standard computer workstation.

10 The CPU 108 determines what video to display and audio to play based upon the interactive commands which it receives. Based upon the commands, it plays the appropriate input from its input devices, which are the Video Selector 10, Video Sources 38, 42 and Hard Disk 34. Audio is received and processed by the Audio Card 30 which sends audio to Speakers 26 and/or  
15 headphones 50 as shown in Figures 1-3.

The user interacts with the program through the Input Device 22. This device may be a customized keypad, a standard computer keyboard, a mouse to "point and click" at selections and also to draw pictures, a touch screen (enabling the user to make a selection by pointing at the screen), a pen-based  
20 input device (for selecting options or draw pictures), a voice recognition device or any other computer input device well known in the art. Furthermore, multiple input devices may be accommodated by the system.

Regardless of the type of input device 22, user inputs can be utilized by the present invention immediately, or at a later time, to result in personalized graphics, video and/or audio presentation. For example, the present invention utilizes "trigger points," as described below, to enable subsequent  
5 branches among multimedia segments during the show. Additionally, more substantive user input, such as pictures and text, may be integrated into the interactive presentation. These types of user input are particularly useful in computer-aided learning applications, since they enable students to participate in lessons utilizing various media. The interactive computer 6 provides the  
10 framework to easily integrate the student's multimedia input into the session and to transmit the multimedia input to other students and teachers, via computer network and/or television broadcast.

As shown in Figure 4, the interactive system of the present invention may operate on a computer network. In this configuration, the program is  
15 processed by the Video Server 70. The programs are sent over the network to the Client Stations 58, 62, 66. Any number of client stations may be supported. The configuration of each client station is preferably the interactive workstation as shown in Figure 3.

The control for integrating the various multimedia elements is  
20 provided by the ACTV authoring language, a unique set of interactive commands to facilitate the interactive process. These commands may either be embedded into data portions of full-motion video segments or may reside separately on a storage medium such as a Winchester disk. When the

commands are embedded within the full-motion video (for example, within the vertical blanking interval), the interactions occur as soon as the computer completes the recognition of a command group. When the commands are stored separately from the video segments in a digital segment, the timing of  
5 their execution is based upon "trigger points." These trigger points are time points at which the interactions are to occur, as explained in more detail below.

The user can view the interactive program either directly using the television set 90 or via the computer 94 screen as shown in Figure 5. Figure 5 is a diagram of an interactive subscriber station, receiving inputs from a  
10 multichannel cable transmission and showing outputs via either the computer 94 screen or a conventional television 90 monitor. Cable channels can be shown in a window on the PC screen using conventional demodulator cards such as a WinTV card. In this embodiment, a cable set top box receives the plurality of analog or digital video/audio signals from the multichannel cable.  
15 The interactive multimedia computer 94 also receives the video/audio signals from the multichannel cable and extracts the data codes, preferably embedded in the vertical blanking interval of the video signal(s). The interactive computer 94 detector detects and extracts data codes embedded in the data stream. These codes are preferably sent to RAM memory and interpreted by  
20 the main processor. Personalized audio and/or video selection occurs by the main processor sending a branching command to the cable set top box. The cable set top box processor interprets the command and seamlessly branches to the selected video.

In the embodiment of Figure 5, the subscriber can receive typical conventional video analog programming from a cable headend. Cable systems also may be used to convey digital data via a system such as the High-Speed Cable Data Service (HSCDS). In a digital system, the subscriber stations may receive programming from content servers or Internet Protocol (IP) routers. Content servers are typically a combination computer and data storage system that stores various types of content from information source providers. These providers might provide anything ranging from video games, distance learning applications, interactive applications, home shopping applications, online magazines and newspapers, databases, and typical network and cable programming. The IP router, on the other hand, formats, switches, and controls the flow of digital data traffic between the cable network and either the public switched telephone network (PSTN), the Internet, or commercial on-line information services, such as CompuServe and America Online. A headend modem modulates the digital data generated by the IP router onto an analog carrier signal suitable for transmission downstream to the subscriber. A typical downstream modulation scheme is 64 Quadrature Amplitude Modulation (QAM).

Each downstream transmission reaches the subscriber's house, shown in Figure 5, preferably through a tap and drop cable. The cable modem demodulates the analog carrier and converts the data to a digital format readable by the user's PC 94. Alternatively, the cable modem can be replaced by an RF demodulator board in the PC, 94.

The programming content associated with the present invention may reside on either a headend-based or a remote content server or one of the storage devices, discussed above (either temporarily or permanently downloaded from the content server). Subscribers gain access to the interactive programming on the server via an online menu.

In this digital embodiment, one channel of digitally-compressed video content would require about 1.5 Mbps to deliver VCR-quality images to the PC 94, while four channels would require about 6 Mbps. Thus, the interactive system of the present invention fits within one 6 MHz channel. At the subscriber station, the interactive seamless system could be implemented in one of the interactive multimedia computers, described below.

#### Seamless Switching between Broadcast Multiple Video Streams

Preferably, the digital video signals are compressed (preferably via MPEG 2 or any other compression scheme) and multiplexed onto a standard NTSC signal. The circuitry in Figures 6-8 below could be implemented on a board and inserted into a standard personal computer (PC). A separate microprocessor on the interactive board is not necessary for this configuration since the standard multimedia PC processor performs the functions of the processor 108 shown in Figures 6-8.

Figures 6-8 show preferred embodiments of the interactive multimedia computer 6 of the present invention to enable seamless flicker-free transparent switching between the digital video signals on the same channel or different

channels. "Seamless" means that the switch from one video signal to another is user imperceptible. These embodiments may be connected to any transmission media or simply connected to the output of any stand-alone storage means (such as CD ROM) for the digitized multiplexed interactive program. Preferably, the interactive computer connects to a television or other display monitor. To provide this capability, only a digital demultiplexer, decompressor(s), frame buffer(s), and sync components are added to the conventional multimedia personal computer. These items, and any other components, may be connected to the PC processor and storage elements in the manner disclosed in Figures 6-8.

Figure 6 shows an embodiment which allows for a seamless video switch between two or more separate digital video signals. As shown in Figure 6, a CPU 108 is connected to an RF demodulator 102 and digital demultiplexer 106. The CPU 108 directs demodulation and demultiplexing of the proper channel and data stream to obtain the correct video signal. Preferably, switches occur at an "I" frame if MPEG2 compression is used. The proper channel is determined either by examination of the user's input from user interface 130 and/or any other information or criteria (such as personal profile information) stored in RAM/ROM 120. For example, the RAM/ROM 120 could store commands provided within the video signals as discussed in patent No. 4,602,279, and incorporated herein by reference. The user interface 130 may be an infrared, wireless, or wired receiver that receives information from a user interface unit.

The RF demodulator 102 is part of the receiver, and demodulates data from the broadcast channel directed by the processor 108. After the data stream is demodulated, it passes through a forward error correction circuit 104 into a digital demultiplexer 106. The demultiplexer 106 is controlled by

5 microprocessor 108 to provide a specific video signal out of a number of video signals which may be located within the data stream on the demodulated broadcast channel. The demultiplexed video signal is then decompressed and decoded by decompressor/ decoder 110. The video signal is synchronized by a sync add circuit 150 and a sync generator 140. The video signal is then buffered

10 by a video buffer 160. The buffered video signal is modulated by a modulator 170 into a NTSC compatible signal.

By using a video frame buffer 160 and delaying the viewing of a given signal, enough time is allowed for the decompressor/decoder 110 to lock onto, decompress, convert to analog, and wait for the resultant vertical interval of a

15 second video signal. For example, assume video signal A is currently being processed and transferred through the circuit shown in Figure 6 and displayed. Based upon a user selection, the microprocessor 108 directs the digital demultiplexer 106 and RF demodulator 102 to switch to another video signal, video signal B. To accomplish this, the analog video from the first digital

20 video signal, video signal A, complete with video sync, is fed into video frame buffer 160. This buffer 160 can hold the full video picture for "n" number of frames after which the signal is output to the display. In effect, a delayed video signal A is viewed "n" number of frames after the signal has been received.

When the user selects a different video path by means of pressing a button on a keypad or entry by other means, the microprocessor 108 instructs the digital demultiplexer 106 to stop decoding signal A and lock onto signal B to begin decoding signal B instead of signal A.

5           While this is happening, even though the decompressor/decoder 110 is no longer decompressing video signal A, the display is still showing video signal A because it is being read from the buffer 160. As soon as decompressing and decoding occurs, the microprocessor 108 looks for the next vertical blanking interval (VBI) and instructs the video frame buffer 160 to switch to its  
10       input, rather than its buffered output at the occurrence of the VBI.

          Since the RF demodulator 102, forward error corrector 104, digital demultiplexer 106, and decompressor/decoder 110 require a certain time period to decompress and decode the video signal B frame from its data stream, the size of the buffer 160 has to be large enough so that this processing can take  
15       place without interruption during the switching of the video signals. If desired, the system may continue to use the buffer 160 in anticipation of a future switch. By using the microprocessor 108 to manipulate the fill and empty rate of the buffer 160, the buffer 160 may be rapidly filled with video signal B frames and then after a period of time will be reset and ready to make  
20       another switch to another video in the same manner. The buffer 160 may also be reset by skipping frames or providing a delay between sequential frame outputs for a short time in order to fill the buffer. If a delay is used to maintain

video signal or frame output while the buffer 160 is being filled a slight distortion may occur for a brief amount of time.

Because a first video signal is always displayed as the output of the buffer 160 after the delay, the buffered video masks the acquisition and decoding of a second video signal. As long as the buffer 160 is large enough to keep the first  
5 video running while the second video is being decompressed and decoded, a seamless switch will occur.

Figure 7 shows an alternate, dual tuner embodiment for seamless switching between separate video signals. In this embodiment, the  
10 microprocessor 108 controls the selection of the RF channel that is demodulated by RF demodulators 102A, 102B. The demodulated data streams enter the forward error correctors 104A, 104B. At the output of the forward error correctors 104A, 104B, the data streams are transmitted to the input of the digital demultiplexers 106A, 106B.

15 As with the RF demodulators 102A, 102B, the digital demultiplexers 106A, 106B are controlled by the microprocessor 108. This configuration allows the microprocessor 108 to independently select two different individual time-multiplexed video signals on different channels and data streams. If all the video signals of an interactive program were contained on a single channel or  
20 data stream, it would only be necessary to have a single RF demodulator, forward error corrector, and digital demultiplexer serially connected and feeding into the two digital video buffers 164, 165.

Two data streams are provided from the digital demultiplexers 106A, 106B. One data stream carries video information pertaining to the video signal the user is currently viewing. The second data stream carries the video signal selected based on the user's previous and/or current interactive selections  
5 from the user interface, as determined by the microprocessor 108.

The digital information on each of the two streams is buffered in digital video buffers 164, 165. The buffered signals are then decompressed and converted into analog signals by decompressors/ decoders 110A, 110B which include digital to analog converters. The decompressors 110A, 110B are  
10 preferably MPEG2 decoders.

A local sync generator 140 is connected to sync add 152, 153 and frame sync circuits 153, 154. Because both streams are synchronized based on signals from the same local sync generator 140, each stream becomes synchronized to the other. In particular, the signals on each stream are frame synchronized.

15 A vertical blanking interval (VBI) switch 180 is connected to the microprocessor 108 so that the input may be switched during the vertical blanking interval of the current stream, resulting in a seamless switch to the viewer.

The embodiment of Figure 7 operates as follows. Based on user  
20 responses and control codes, it is assumed that the microprocessor 108 determines that a switch from video signal A to video signal C should be performed. RF demodulator 102A and digital demultiplexer 106A are processing the currently viewed video signal, video signal A, which is

progressing through the upper branch components. A command is issued from the microprocessor 108 to the RF demodulator 102B commanding a switch to the channel and data stream on which video signal C is located. The microprocessor 108 also instructs the digital demultiplexer 106B to provide  
5 video signal C from the received data stream to digital video buffer 165.

At this point, the upper RF demodulator 102A and digital demultiplexer 106A are still independently receiving and processing video signal A, which continues through the upper branch of the circuit.

At a certain point, the digital decompressor/decoder 110B in the lower  
10 branch will begin filling up with video C frames. After the video signal C is decompressed and decoded, it is converted into analog. A local sync generator 140 inserts both local sync and frame sync to video signal C via sync add circuit 152 and frame sync circuit 154 in order to synchronize it with the currently displayed video signal A, which is still being provided from the upper digital  
15 video buffer 164. At the appropriate switch point, triggered by programming codes supplied with each video signal A and C, the microprocessor 108 directs the VBI switch 180 to switch in the vertical blanking interval from video A to video C, at which time video C will then seamlessly appear on the computer screen.

20 Digital video buffers 164, 165 may be used in the circuit of Figure 7, but are optional. However, in an alternative embodiment the buffers, 164, 165 would be required to provide a seamless switch if the Figure 7 circuit was modified to incorporate a single RF demodulator 102, single forward error

and digital demultiplexer to switch to video signal C and the time required for decompression, decoding, and synchronization of video signal C.

When video signal C is synchronized with video signal A, the microprocessor 108 directs VBI switch 180 to switch from video signal A to video signal C in the vertical blanking interval of video signal A, thereby  
5 providing a seamless and flicker-free switch.

At this time, digital video buffer 165 will begin to utilize maximum buffering by altering its fill/empty rate as described above with respect to the Figure 7 embodiment. When adequate buffering is achieved, a switch to  
10 another video signal may be performed in the same manner as described above.

Another preferred embodiment is shown in Figure 8. This embodiment also includes an RF demodulator 102, a forward error corrector 104, and a digital demultiplexer 106. However, the circuitry differs along the rest of the chain to the television set or monitor. In this embodiment, a memory 190 is  
15 incorporated and connected to the output of the demultiplexer 106 for storing the compressed composite digital video signal. The decompressor/decoder 110 is inserted at the output of the compressed memory 190. The decompressor/decoder 110 decompresses the digital signal, converts the signal  
20 to analog and forwards the analog signal to the RF encode, 170 for transmission to the monitor. Once the composite compressed digital video signal is fed into the compressed memory 190, the microprocessor 108 directs a pointer to be placed somewhere along the compressed digital video signal. Based on the

placement of the pointer, different frames and different segments of the composite digital video signal will be read from memory 190 for decompression and decoding.

The different video signals are distinguished from one another because they are labeled, preferably by headers. Assuming that video signal A has been selected for play on the monitor, the compressed digital memory 190 fills up with A frames. Assuming a switch to video signal C is desired, the microprocessor 108 directs the RF demodulator 102 and digital demultiplexer 106 to begin filling the compressed memory 190 with video C frames. The decoder pointer begins to move down. As soon as a sufficient number of C frames have entered the compressed memory, the pointer will then jump to the beginning of the C frames. The C frames are then output into the decompressor/decoder where the digital frames are converted into an analog signal.

The digital video is multiplexed in a series of easily identifiable packets. These packets may contain full compressed frames of video (I frames) or may include only the differences between full frames (B frames or P frames).

To be able to reconstruct the full video images, the decompressor/decoder 110 needs to have a minimum number of I, P and B frames. The decoder 110 needs only one I frame to decode an image. Conversely, two prior Anchor frames ("I's" and "P's") are necessary to decode B frames. In order to decode P frames, the decoder 110 only needs one Prior Anchor frame. When the microprocessor 108 instructs the digital demux 106

to start sending packets from a different data stream there is no way to be certain that the next packet will be an I packet needed for decoding the second video stream. To avoid a breakup of the video images, which would occur if the decompressor/decoder 110 suddenly started receiving packets unrelated to the stream it was decoding, the microprocessor 108 starts to fill up the memory 190 with video signal C packets until it is determined that a full sequence of I, B and P frames are available. The decoder, 110 should receive the last bit of the last B frame in a given, GOP (Group of Pictures) before the switch, in order to prevent glitches when decoding. Furthermore, the last B frame of the GOP must only be backward predicted, not forward predicted or bidirectional predicted. As soon as the valid sequence is in memory 190 the microprocessor 108 moves the memory read pointer to the start of a valid sequence of C video signal packets so that the decompressor/decoder 110 can successfully decode the C signals. This results in a seamless switch from video signal A to video signal C.

This embodiment requires a data channel for enabling a synchronous switch between a first video stream and a second video stream. This data channel comprises the ACTV codes which link together the different program elements and information segments on the different video signals. In addition, the data channel also comprises synchronization pulses and a time code to signify to the pointer the proper time to skip from a memory location representing one video signal to a memory location representing another video signal in order to enable a seamless switch.

channel effectuates the linking between each video signal and a corresponding time point. The data channel also includes information designating when all the various video signals will be in synchronism with one another. It is at these points that the microprocessor 108 may direct the pointer to skip from one location to another location, at a time (such as during the VBI) when a seamless switch will result.

### Trigger Points

Interactivity is further enhanced in the interactive computer workstation embodiments through the application of trigger points 900 scattered at various predetermined times throughout the program, a timeline representation of which is shown in Figure 9. The trigger points 900 correspond to times when interactive events are scheduled to take place. These interactive events could be the selection and playing of video, audio segments or the display of graphics. While the choice of particular video, audio or graphics is still dependent on viewer selections, the viewer selections in response to displayed graphical interrogatory messages are preferably made during a period at the onset of the program or when a viewer first tunes into the program. These viewer selections are then utilized as inputs to macros called up at later times during the program by the controller upon the occurrence of the trigger points, identified to the interactive computer by unique codes embedded in the video signal.

or perhaps hear the local announcer instead of the network announcer. Upon the viewer selection, the CPU directs a branch to the appropriate interactive segment.

Each trigger point is identified preferably through the broadcast of ACTV  
5 codes sent as part of the composite interactive program signal. The codes preferably include, at a minimum, the following information: (1) header identifying the occurrence of a trigger point; (2) function ID (e.g., selection of audio or graphics responses, etc.); and (3) corresponding interrogatory message(s). The first bit sequence simply identifies to the controller that a  
10 trigger point is about to occur. The function ID designates the macro or other set of executable instructions for the controller to read and interpret to obtain the desired result, e.g., a selected video and/or audio response.

Upon extraction of the codes by the data decoder, the CPU 108 reads and interprets the codes and calls from memory a particular user selection(s)  
15 designated by the trigger point codes. The user selections correspond to subscriber answers to a series of interrogatory messages preferably presented at the beginning of the program. After obtaining the appropriate user selection(s), the controller 108 reads and performs the executable instructions using the user selection(s) as input(s) in the macro algorithm. The result of the  
20 algorithm is either a selected video stream, audio and/or selected graphics response. The video/audio response can be called from memory if it is prestored, called from external data storage, or the controller can command the switch to branch to the particular video audio stream if the response is

broadcast concurrently with the trigger point. After the selected video/audio response is played to the subscriber, the switch branches back to the standard program, shown at time  $t_s$  in figure 9.

As mentioned above, a series of interrogatory messages are preferably  
5 presented when the subscriber begins watching the interactive program. These  
interrogatory messages can be presented in any one of three ways. First, the  
interrogatory messages can be presented as graphics displays overlaid by the  
interactive computer workstation onto a video signal, wherein the graphics  
data is sent in the vertical blanking interval of the composite interactive signal,  
10 or alternatively stored on the hard disk or external storage. Second, the  
interrogatory messages are presented as graphics displays as discussed above,  
except the graphics data comes from local storage, external data storage (e.g., CD  
ROM, cartridge, etc.), or a combination of data in the VBI and data called from  
either local or external data storage. Third, graphics data can be presented in  
15 the form of user templates stored at the interactive computer workstation.

User selections corresponding to answers to the  $n$  successive  
interrogatory messages are received by the remote interface at the beginning of  
the show, stored in memory and used throughout the show at the appropriate  
trigger points to subtly change program content as the show progresses.  
20 Preferably, each interrogatory has a set of possible answers. Next to each  
possible answer will be some identifier corresponding to a label on a key on the  
user interface. The subscriber depresses the key corresponding to their answer  
selection. This selection is decoded by the remote interface and controller,

stored in memory, preferably RAM, and used later as required by an algorithm designated at a trigger point.

5           Single Video Channel Interactive Computer Embodiments Providing  
Personalized Audio Responses

While such interactive programming may include a plurality of video signals, the interactive multimedia computer work station 6, described herein, may also provide for personalized audio interactivity by way of a single  
10   standard video and audio television signal with a plurality of additional audio signals and/or graphics data for providing interactivity, as shown in Figures 10-13. The interaction with the subscribers comes primarily by way of selection of one or more linked audio segments from a plurality of audio segments, whereby the selected audio segment(s) are chosen as a function of previous  
15   user responses. Interactivity is enhanced through the use of overlaid graphics displays on the video which like the audio responses, also vary according to selections made by the subscriber on the user interface. Audio segments are used to provide personalized responses to subscriber selections. The graphics, on the other hand, are used to both query the subscriber, preferably at the  
20   beginning of the program, and also to provide personalized graphical messages to subscribers. The interactive show also comprises control data for controlling the interactive computer work station.

Multiple audio segments forming the set of suitable responses to an interrogatory message can be sent as part of a standard video signal. There are  
25   a number of different ways to effectively forward the necessary audio segments

for a given interactive event to the interactive computer. The interactive elements may be broadcast synchronously (alternative responses aligned in time), serially, on separate channels, embedded in the existing video and/or transmitted before or during the program. Audio segments tagged for a given interactive event, can be sent to the interactive computer work stations much earlier than the scheduled event during the program, in which case the segments are preferably stored in temporary memory, or the segments can be transmitted concurrently with the event. With the present invention, it makes no difference how the audio segments reach the interactive computer work station as long as they are available for selection at the computer 6 at the predetermined "trigger points," described below. For example, the audio segments could also be stored in local external data storage such as CD-ROM.

In one preferred "trigger point" embodiment, interactive audio shows can be delivered in the standard television channel. In this embodiment, four audio responses are available at each trigger point, however, only two audio channels need be broadcast, or otherwise input, to the interactive computer 6.

This embodiment has the advantage of requiring merely one television channel. Channel 1 is the "home" channel. When channel 1 is playing, channel 2 is used to download the audio for tracks 3 and 4 to the interactive computer 6. This downloaded audio is stored as wave files in the local unit. When it is time to branch, audio tracks 1 and 2 are played on the two audio input channels, while tracks 3 and 4 are generated from the audio wave files

on the interactive computer 6. A seamless branch is made from any one of these channels to any of the other channels.

Figure 10 shows an overview of a preferred interactive computer work station embodiment. Other digital and audio alternative embodiments for the provision of audio interactivity are shown in figures 6-8 of U.S. Patent Application Serial No. 08/289,499, herein incorporated by reference. The embodiments represent different apparatus for receiving, processing and storing the alternative interactive audio segments which are received in different transmission formats. With these embodiments, the interactive systems are no longer solely limited to selecting audio from multiple parallel tracks of audio, related in time and content, nor is the interactive questions-immediate answer format, as disclosed in previous patents, necessary. Of course, the systems of the present invention can still use the question-immediate answer format or a combination of such format and delayed response via trigger points. The concept remains the same, i.e., to select audio responses which are matched to user selections by some function.

The elements of the audio interactive embodiment can be incorporated and provided by the interactive multi-media work station. Preferably, this configuration comprises a video demodulator board, a keypad for entering subscriber selections, an extractor board for separating the audio signals and data from the conventional video signal, temporary and permanent data storage, a modem (optional), audio switch and a processor.

The microprocessor 178 interprets the extracted data as either control data, including instructions for switching between voice channels, or graphics data for on screen display. If the data is on-screen display data, the data is preferably prefixed by a command designating the data as on-screen display data, as opposed to control data. In the preferred embodiment, the controller 178 also examines the control data for the occurrence of a header code designating the onset of a trigger point in the program.

If the trigger point codes designate a macro which calls for the placement of a graphics display on the video, the microprocessor 178 reads the codes, accepts any graphics data sent from the head-end, calls for and examines the actual bit maps stored in memory 284 or external memory 629 and designating the identity of the characters, and then commands the character generator 624 to overlay particular characters at particular points on the screen. Therefore, the graphics are preferably generated locally with the bit maps stored in memory 289. The graphics are selected for presentation either in predetermined sequence, through the use of control codes in the composite interactive program, developed when the program was created at the operations center, or more flexibly through the execution of algorithms by the processor 178 utilizing stored subscriber selections to previous graphic interrogatory messages. The algorithms are preferably part of the operating systems software stored in memory at the interactive work station. Alternatively, the algorithms could be included in the data portion of the composite interactive signal.

The graphics can be utilized to overlay any portion of the screen of the television screen. The character generator 624 is locked by a Gen-lock circuit 623 which allows for the synchronous placement of the graphics on the video. The character generator 624 is preferably a standard on-screen display chip  
5 which takes incoming video, locks the video and superimposes on the video the characters as instructed by the microprocessor 178. Specifically, the character generator 624 is a switching system which takes the active lines of video and switches to a mode of sending the graphics characters for a predetermined time, and then switches back to the video when the character is finished being  
10 written on the screen.

Because the graphics are generated locally, subscribers without the interactive multimedia computer 6 are not be able to view the graphics. For those subscribers possessing the interactive capability, the graphics can be used for both posing interrogatory questions to subscribers at the onset of the  
15 program, consistent with the trigger point embodiment, posing questions during the program, or used to provide a personalized response to previous individual subscriber selections.

Preferably at the beginning of the program or when a viewer first tunes in, a series of interrogatory messages are presented to the subscriber. The  
20 subscriber responds to the interrogatory message by depressing a button via the user interface device corresponding to an answer selection listed on the interrogatory graphics screen. If the subscriber has made a selection using a remote, a signal is received by the IR interface 628 which processes the signal

and forwards the signal to the processor 178. The processor preferably creates a packet comprising the user selection and a header code that identifies the particular interrogatory message associated with user selection and sends the packet to memory 284. Each user selection to each interrogatory is stored in  
5 this fashion. These selections will be called later in the program at appropriate times when identified by the trigger point codes and then used in macros or algorithms to determine interactive audio and/or graphics responses.

The presentation of the graphics interrogatory messages can also be made a function of subscriber selections to previous interrogatory messages.  
10 The logic used in the codes for selecting the next graphics message is similar to that used for selecting audio messages. One method, as disclosed in earlier ACTV patents, is the "decision tree" logic methodology. The subscriber makes a selection to a first predetermined interrogatory graphics message. After the subscriber hears an appropriately branched audio channel, the processor 178  
15 will interpret graphics algorithmic codes sent down from the operations center 608 and will read from memory 284 an appropriate next graphics message. The processor 178 then directs the character generator 624 to overlay the selected graphics message onto the next frames of video.

The advantages discussed above in relation to presenting an interactive  
20 program using trigger points are obtainable in each of the interactive computer embodiments shown in figures 11-13. In the embodiment shown in figure 11, alternative audio segments are preferably sent serially from the operations center in the SAP channel. The demodulator 617 receives a composite

interactive signal comprising the standard video and standard audio signal along with an audio subcarrier. The demodulator 617 breaks the signal into its component parts, forwarding the baseband video to a data extractor 175 and the standard audio to an audio switch 620. The line 21 data extractor 175 takes out  
5 the data codes, including the trigger points.

The SAP channel comprises a plurality of audio segments lined up serially. The audio segments are digitized in the analog to digital converter 750 and are preferably stored in digital audio memory 283. At certain times during the program, data codes will designate a trigger point and key the  
10 microprocessor 178 to select and play an audio segment corresponding to previous user input(s), according to the process described above. The microprocessor 178 calls the appropriate audio segment(s) from internal memory or external data storage 629 and commands the audio switch to pass the selected audio segment to the RF modulator 622 for play to the subscriber.  
15 At the end of the interactive time period, the controller 178 instructs the audio switch 620 to again pick up the standard audio.

In an alternative embodiment similar to that as shown in Figure 11 and discussed above, the simple addition of a second tuner, receiving the composite RF signal, could be used to tune to a second audio channel for  
20 collection of transmitted audio segments. The tuner would pass the audio segments to the A/D converter with the operation of the rest of the interactive computer workstation similar to that described above in connection with Figure 11.

Figure 12 shows another interactive computer workstation embodiment for providing alternative audio and graphics segments. This embodiment uses two tuners: an RF demodulator 616 and a data tuner 615. The RF demodulator 616 tunes to and demodulates the conventional video and audio signal in the standard video bandwidth. The data tuner 615 receives a single digital audio signal. The signal comprises digital serial audio segments modulated onto an analog carrier. The data tuner 615 demodulates the signal into digital audio. The digital interface selector and error corrector 177 separates the audio segments and performs error correction according to any error correction scheme commonly understood in the art. The controller 178 directs the selector 177 to extract selected digital audio segments from the serial digital stream and send them to the digital audio memory 283. Selection of one or more audio segments for play as personalized messages on the speakers occurs according to the processes described above. After the controller 178 commands the memory 283 to forward a digital audio segment, the segment is converted to analog by the digital to audio converter 176 and is subsequently passed to the RF modulator 622 for play on the speakers.

Another interactive computer workstation embodiment for receiving, storing and selecting alternative audio segments is shown in figure 13. At the operations center, the audio segments are digitized, time division multiplexed, modulated and converted to frequencies in unused channel frequency space in the cable television spectrum, e.g., cable guard bands.

The RF demodulator 616 again demodulates the conventional video and audio signal. The data extractor 175 receives the signal and extracts the VBI line 21 data codes. The data in the VBI indicates the frequency channels in which the digital audio segments are transmitted. For example, audio  
5 messages A-E are located in between channels 14 and 15. The controller 178 instructs the data tuner 615 to tune to that part of the spectrum between channels 14 and 15. Alternatively, an autotune capability can be used to find the audio channels in the spectrum.

The tuner 615 demodulates the digital audio signal and forwards the  
10 signal to the digital demultiplexer 700. The demultiplexer 700 demultiplexes the signal into n digital audio channels and forwards each channel to a separate D/A converter 702-710 where each of the digital channels are converted to analog audio. As described above, one of these channels can be selected as identified at the trigger points for play over the audio speaker to the  
15 subscriber.

The embodiments described above and shown in connection with figures 10-13 relate to different ways of receiving broadcast audio segments. Alternatively, interactive audio segments, or graphics elements, could be prestored on cartridge, CD ROM, an audio card, or even floppy disk.

20 Even more enhanced and flexible operation can occur through the addition of external data storage, such as CD ROM or cartridge. For example, sports statistics or other information on athletes or others can be stored in CD ROM. During live sports event either audio segments or graphics displays

focusing on the athlete can be called by the processor and presented to the viewer as a function of user selection of an option or at a trigger point if the user indicated during queries at the beginning of the live event that they were interested in a particular player.

5

### Memory

The interactive computer also has the advantage of remembering subscriber responses and using these responses in choosing a video/audio response, and/or graphics interrogatory message, to present to the student.

10 Memory branching is a technique of the present invention where the algorithm assembles video/audio responses and graphics interrogatory messages according to the current and previous user inputs. Memory branching is accomplished by linking video/audio streams and/or successive graphics interrogatory messages together in a logical relationship, as described  
15 in U.S. application no. 08/228,355, herein incorporated by references. In this scheme, the interactive computer processor contains logic (preferably, in the software algorithm) and memory to store previous subscriber selections and to process these previous responses in the algorithm to control future video/audio stream selection, as well as future graphics message selection.

20

### User Profiles

In a preferred embodiment, the interactive computer can have stored in its memory a "user profile." The "user profile" preferably contains

characteristics of the particular viewer at that subscriber location, such as sex, hobbies, interests, etc. This user profile is created by having the user respond to a series of questions. Alternatively, the user profiles could be created at a host and sent to the interactive computer over a network. This information is then  
5 used by the interactive computer software to create a compendium of the viewer's interests and preferences -- i.e., a user profile. The stored user profile would be used in place of the question/answer format, and thus, dictate the branches to interactive segments of interest to the viewer.

Alternatively, the interactive computer 6 can be programmed to create a  
10 user profile of each viewer based on the selections made during one of the interactive programs. Furthermore, such a user profile could be modified or enriched over time based on selections made during future interactive programs. For example, the 'memory' technique described above can be used to modify the user profile based on user response over time.

15 Once the profile is created, the programming choices or interactive responses can be triggered based on the content of the user profile itself. For example, if the user profile suggests that the viewer is particularly interested in sports cars, a sports car commercial could be played for the viewer at a predetermined point in the program. As another application, if a viewer's user  
20 profile indicates that the viewer is interested in cooking, whenever the viewer watches such a program, the user profile would trigger the interactive program to download recipes and either display such recipes on the screen or send the recipes to an attached printer.

### Applications

The embodiments, described above, allow for several possible applications. For example, in a live sports event, one channel could carry the standard video channel, with other channels carrying different camera angles and/or close-ups of particular players.

Audio interactive applications include the recording of audio clips for each player in the game. In this application, the viewer may access a pull-down menu, where he can choose a name of a particular player in the game. When this selection is made, the appropriate audio segment is called from memory and played for the viewer. In a similar manner, statistics in the form of text and graphics can be displayed for a selected player.

### Internet Applications

Interactive programs of the present invention can be created using the Internet. Interactive program authors can access a particular Internet site and download graphics, audio and video clips and suggested interactions. The author can then use these elements in the authoring tools to create an interactive program.

Furthermore, viewers can watch interactive programs from the Internet itself using the systems of the present invention. From an Internet site, viewers can access a single channel interactive program, such as described above. The viewer would watch the video on his or her computer, while the

audio and/or text/graphics from Web site locations, for example, would be presented as a function of his or her specific choices via interactive commands.

In addition, viewers can choose between multiple video streams originating from a site on the Internet. The seamless branching between  
5 different video streams would occur through interactive commands resident in the viewer's computer.

Using the foregoing embodiments, methods and processes, the interactive multimedia computer maximizes personalized attention and interactivity to subscribers in their homes in real time. Although the present  
10 invention has been described in detail with respect to certain embodiments and examples, variations and modifications exist which are within the scope of the present invention as defined in the following claims.

We claim:

CLAIMS

1. An interactive computer work station for presenting an integrated multimedia interactive presentation, comprising:

5 a means for displaying an integrated audio, graphics and video presentation, the presentation comprising a common audio and common video signal, and at predetermined times, at least two selectable user options corresponding to an interrogatory message;

10 a means for interacting with the integrated presentation, wherein the user is prompted to interact with the integrated presentation in response to the interrogatory message by selecting one of the user selectable options;

a means, connected to the interaction means, for determining an appropriate personalized feedback response, wherein the feedback response may consist of video, audio and graphics segments and the selected feedback response is based on one or more user selected options; and

15

a means, connected to the determination means, for presenting the appropriate personalized feedback response to the viewer, wherein the appropriate personalized feedback response may occur immediately after user selection or at a later predetermined time in the integrated presentation.

20

2. The interactive computer work station of claim 1, wherein the interactive computer work station further comprises:

a plurality of video sources, each source storing a separate and distinct video segment, wherein the common video signal contains data commands;

a means, connected to at least one video source, for extracting data commands, wherein the data commands comprise branching codes;

5 wherein the determination means comprises:

a means for detecting the branching codes; and

a means, connected to the detection means, for processing the branching codes, wherein the personalized feedback response is based on the branching codes and the user selected options.

10

3. The interactive computer work station of claim 1 further comprising:  
an audio card, connected to the determination means, for storing the plurality of different audio segments.

15 4. An interactive computer work station for presenting an integrated multimedia interactive presentation, comprising:

a means for receiving a common video signal and a plurality of different video segments, wherein the common video signal has embedded data commands;

20 a means for displaying an integrated audio, graphics and video presentation, the presentation comprising a common audio and the common video signal, and at predetermined times, at least two selectable user options

corresponding to an interrogatory message, the interrogatory message presented as part of the video signal;

a means, connected to the receiving means, for extracting data commands, wherein the data commands comprise branching codes;

5 a means for interacting with the integrated presentation, wherein the user is prompted to interact with the integrated presentation in response to the interrogatory message by selecting one of the user selectable options;

a means, connected to the interaction and extracting means, for determining an appropriate personalized feedback response, wherein the  
10 feedback response may consist of video, audio and graphics segments and the selected feedback response is based on one or more user selected options and the branching codes; and

a means, connected to the determination means, for presenting the appropriate personalized feedback response to the viewer, wherein the  
15 appropriate personalized feedback response may occur immediately after user selection or at a later predetermined time in the integrated presentation.

5. The interactive computer work station of claim 4 further comprising:  
an audio card, connected to the determination means, for storing the  
20 plurality of different audio segments.

6. An interactive computer work station for presenting an integrated multimedia interactive presentation, comprising:

a means for receiving a common video signal and a plurality of different video segments, wherein the common video signal has data commands;

a means for displaying an integrated audio, graphics and video presentation, the presentation comprising a common audio and the common video signal, and at predetermined times, at least two selectable user options corresponding to an interrogatory message, the interrogatory message presented as part of the video signal;

a means, connected to the receiving means, for extracting data commands, wherein the data commands comprise branching codes and trigger points;

a means for interacting with the integrated presentation, wherein the user is prompted to interact with the integrated presentation in response to the interrogatory message by selecting one of the user selectable options;

a means, connected to the interaction and extracting means, for determining an appropriate personalized feedback response, wherein the feedback response may consist of video, audio and graphics segments and the selected feedback response is based on one or more user selected options and the branching codes; and

a means, connected to the determination means, for presenting the appropriate personalized feedback response to the viewer, wherein the appropriate personalized feedback response occurs upon the occurrence of one of the predetermined trigger points.

1/13

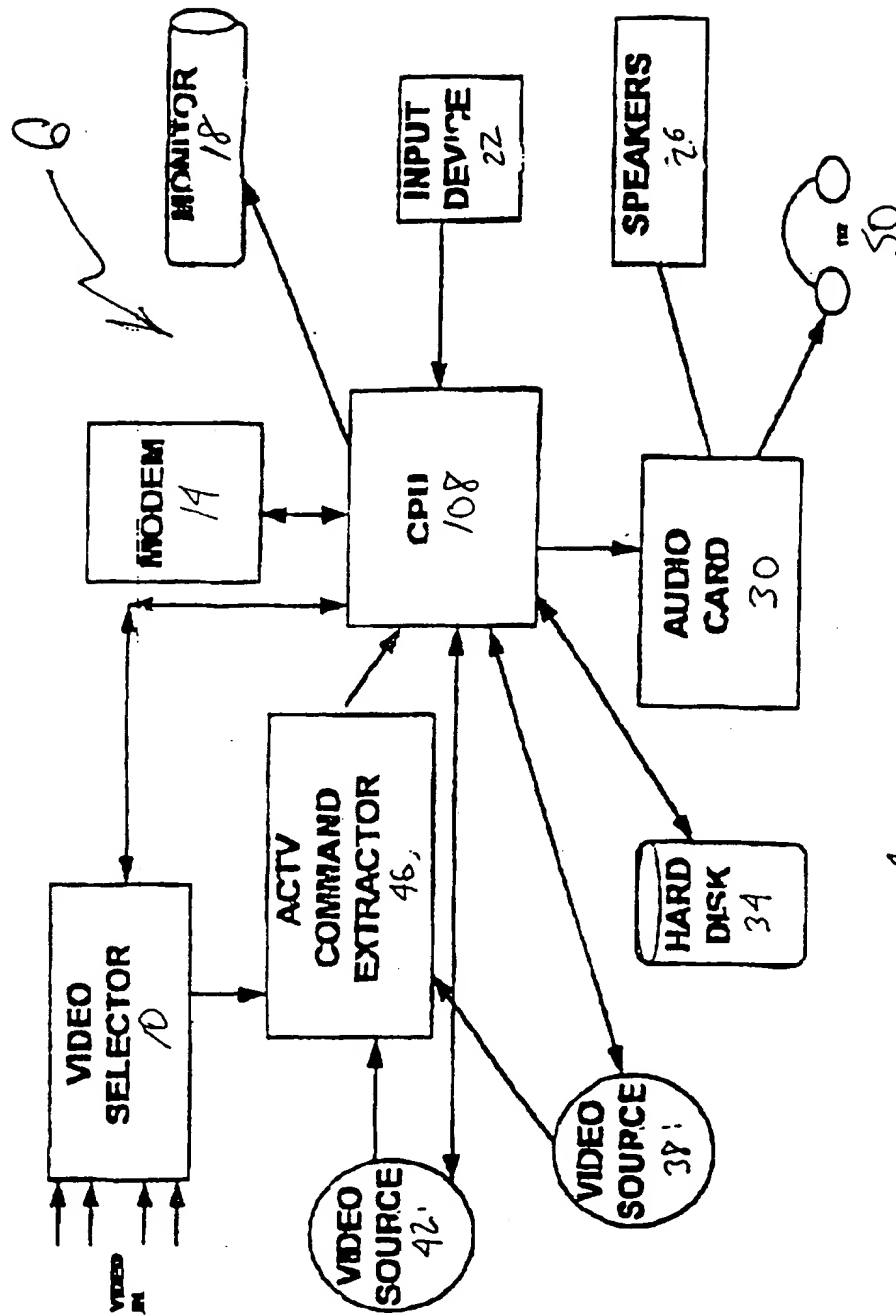


Figure 1

2/13

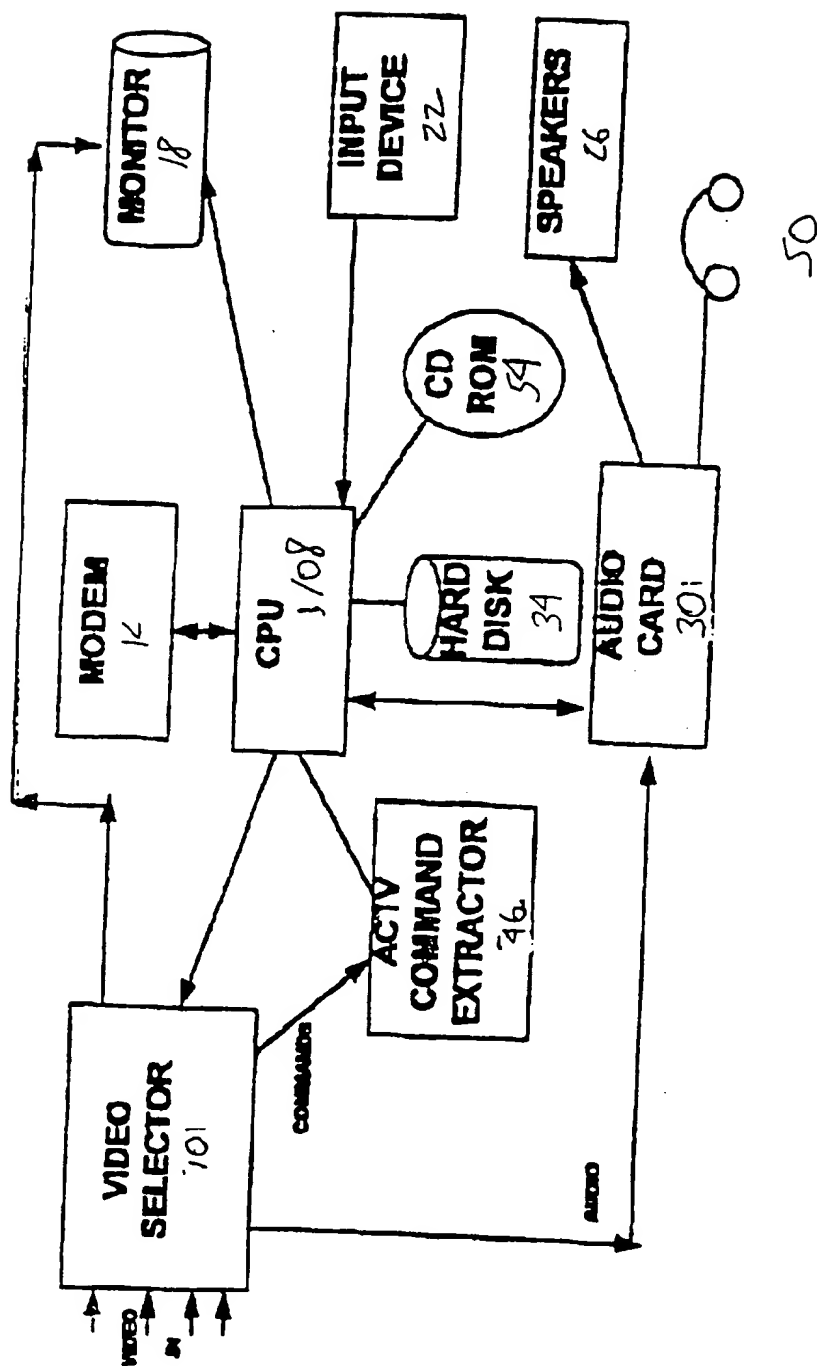


Figure 2

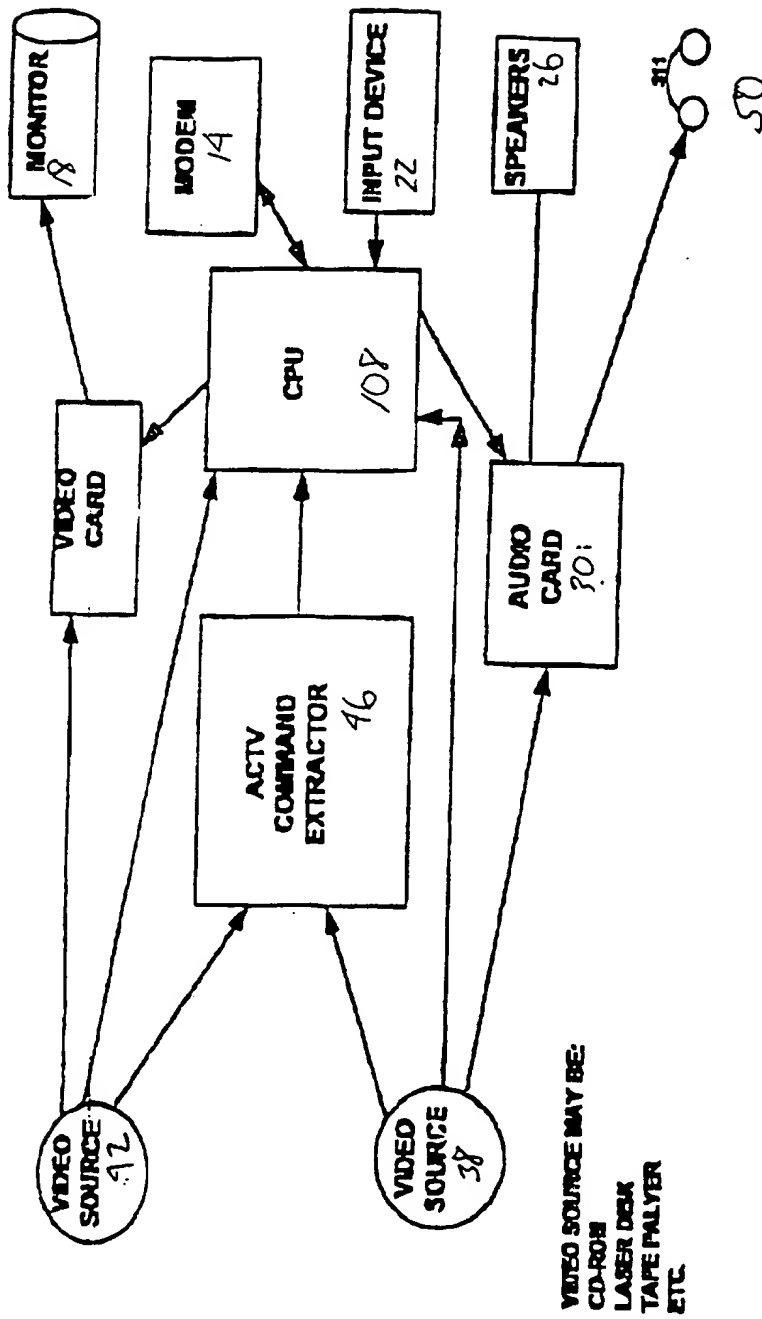
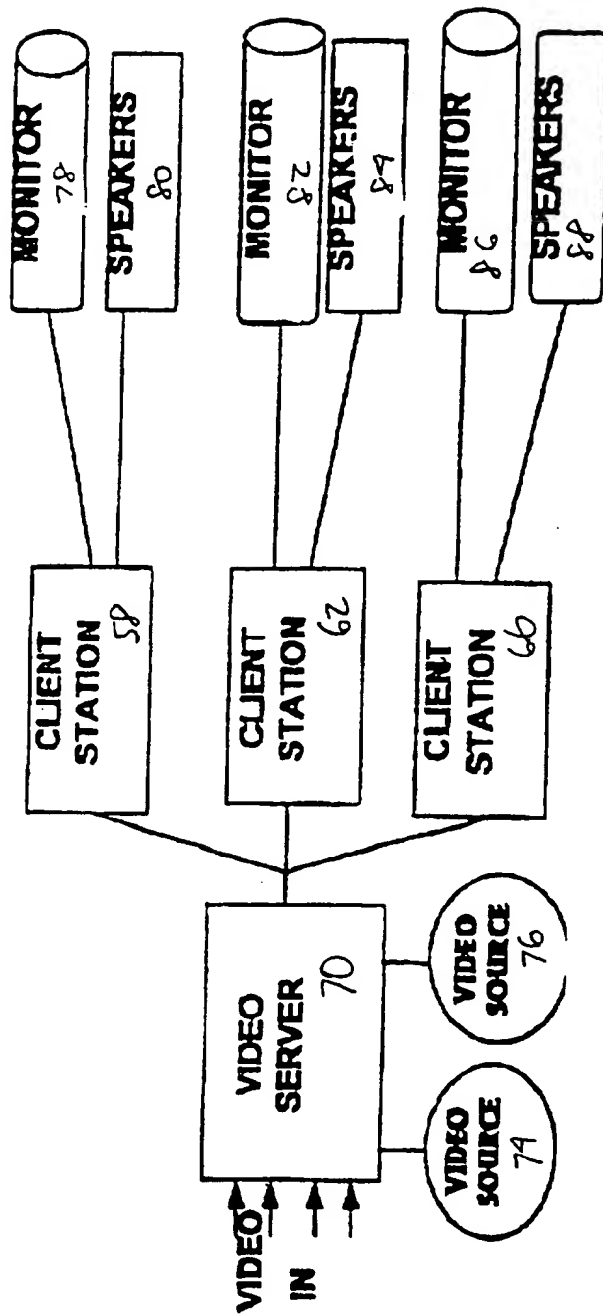


Figure 3

4/13

*Figure 4*

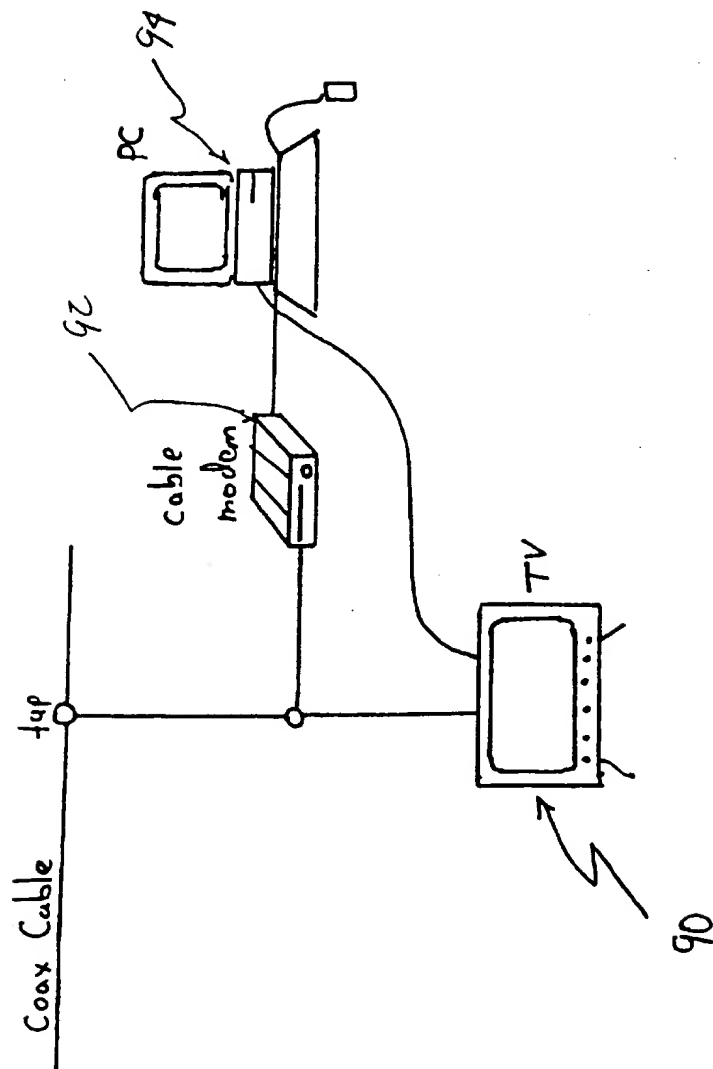


figure 5

6/13

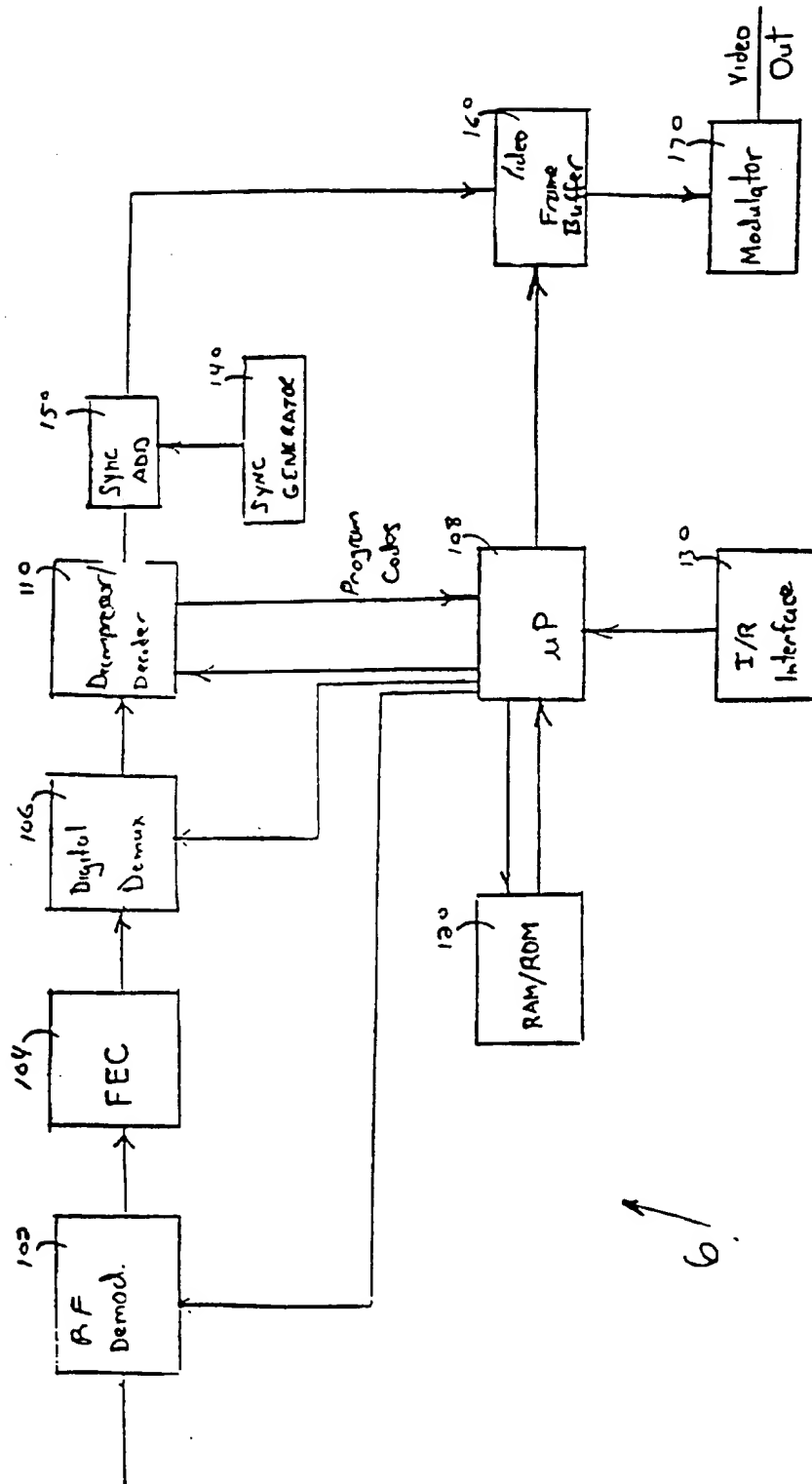


Fig. 6

7/13

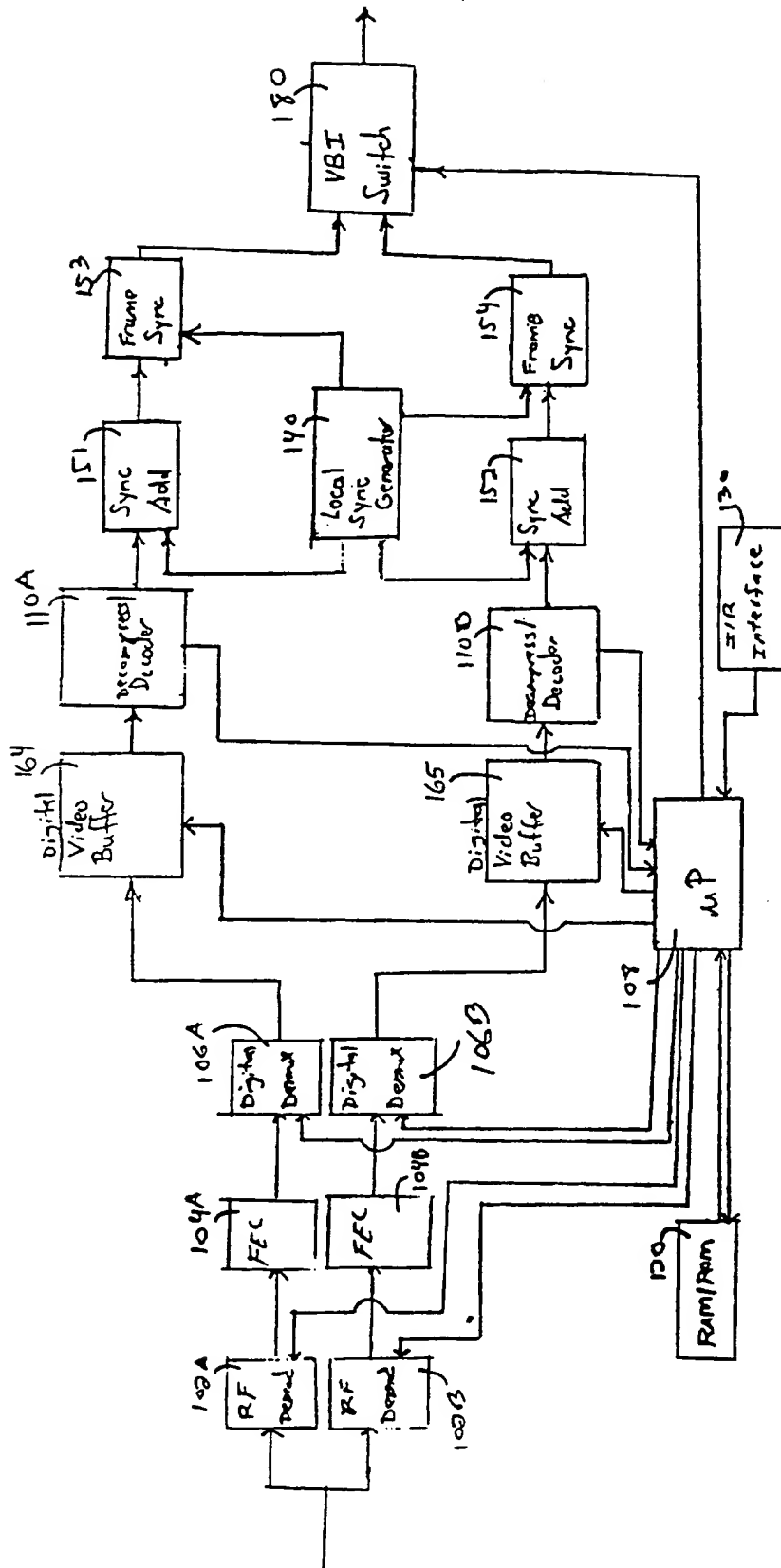


Fig. 6

8/13

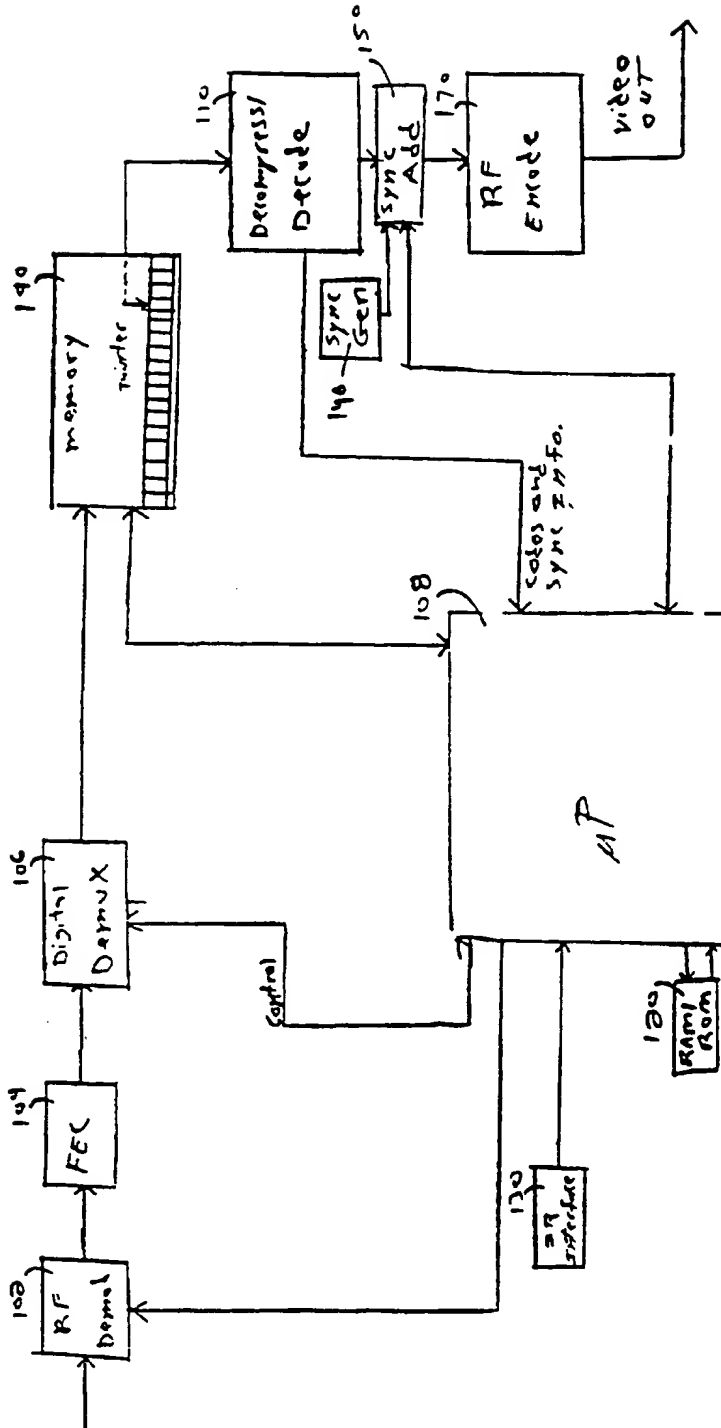


Fig 8

6

9/13

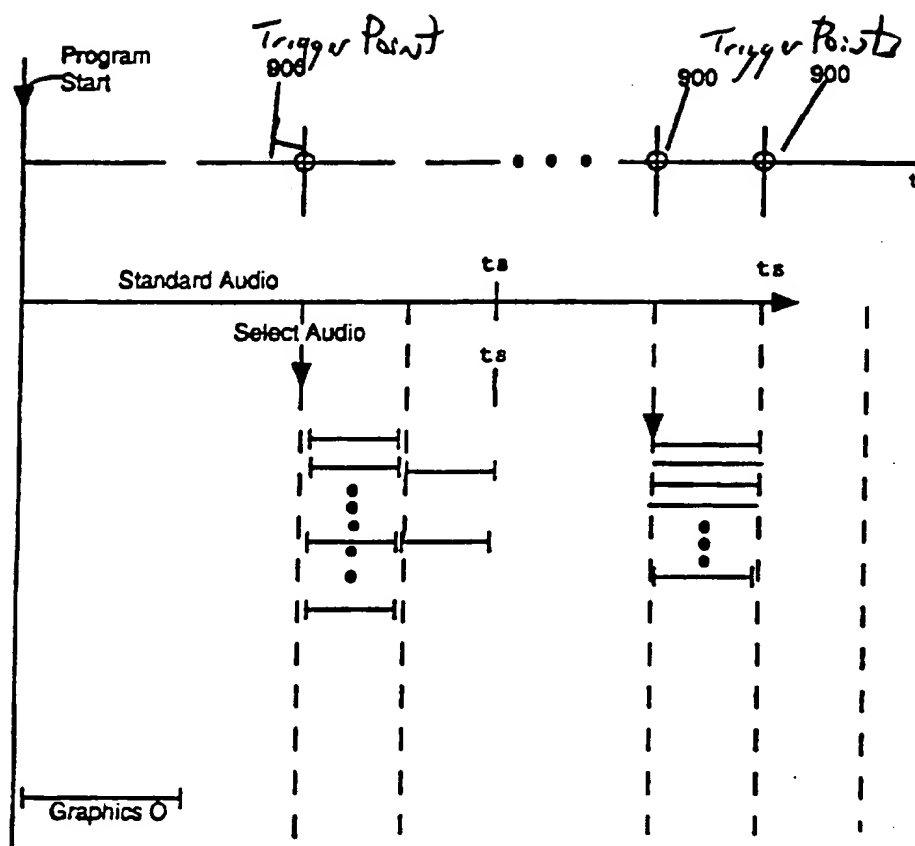
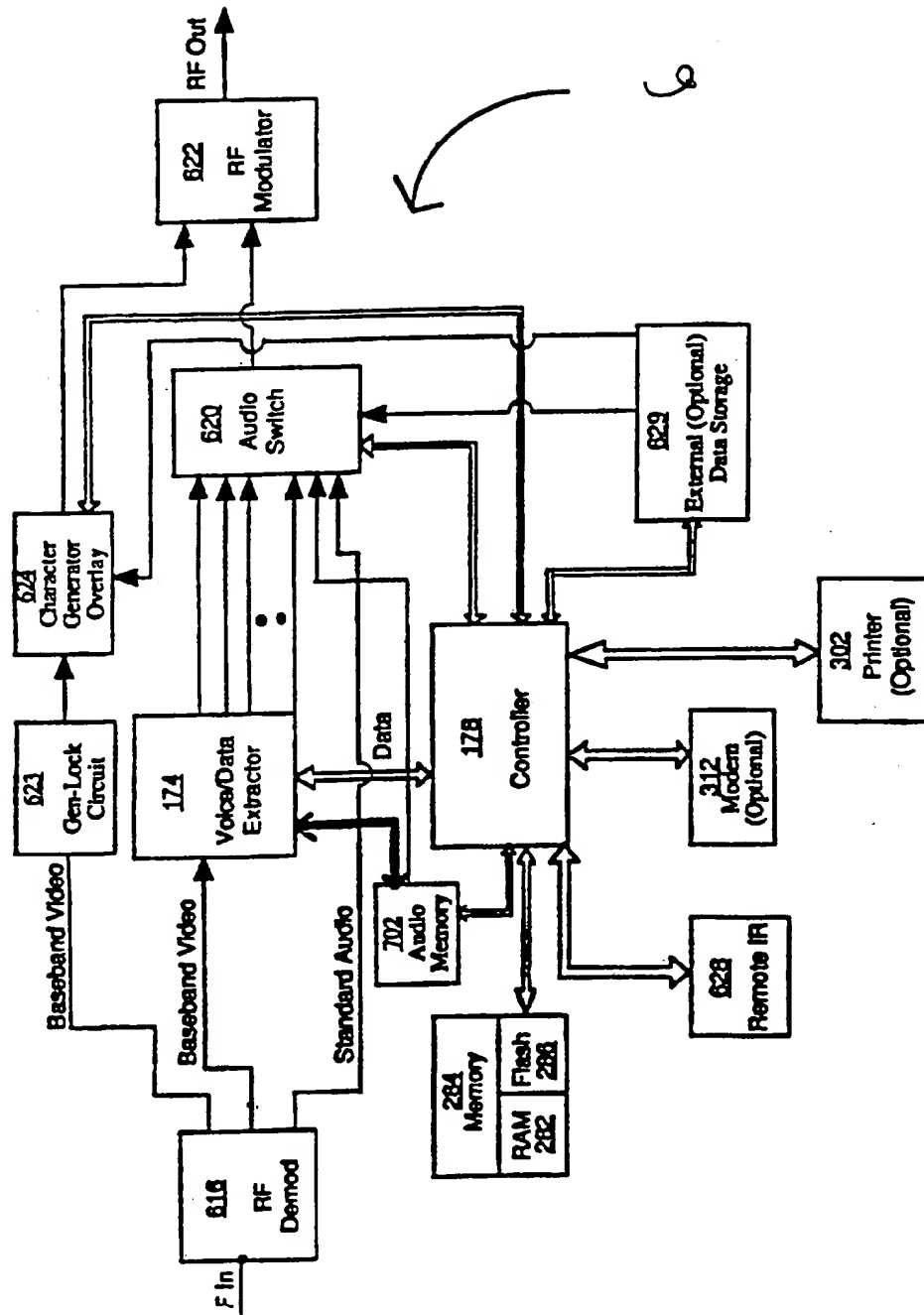
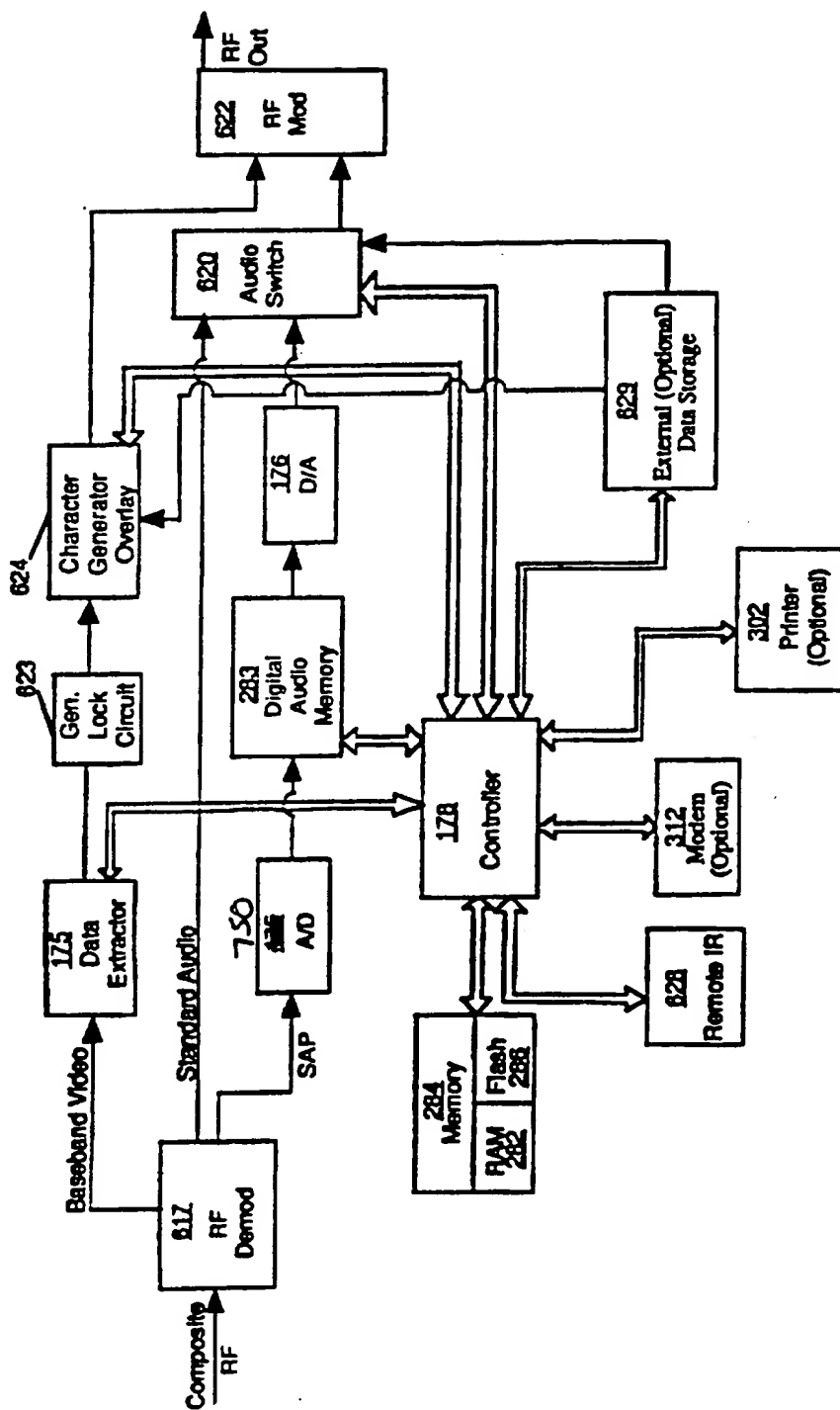


Figure 9

10/13



*Figure 10*



*Figure 11*

12/13

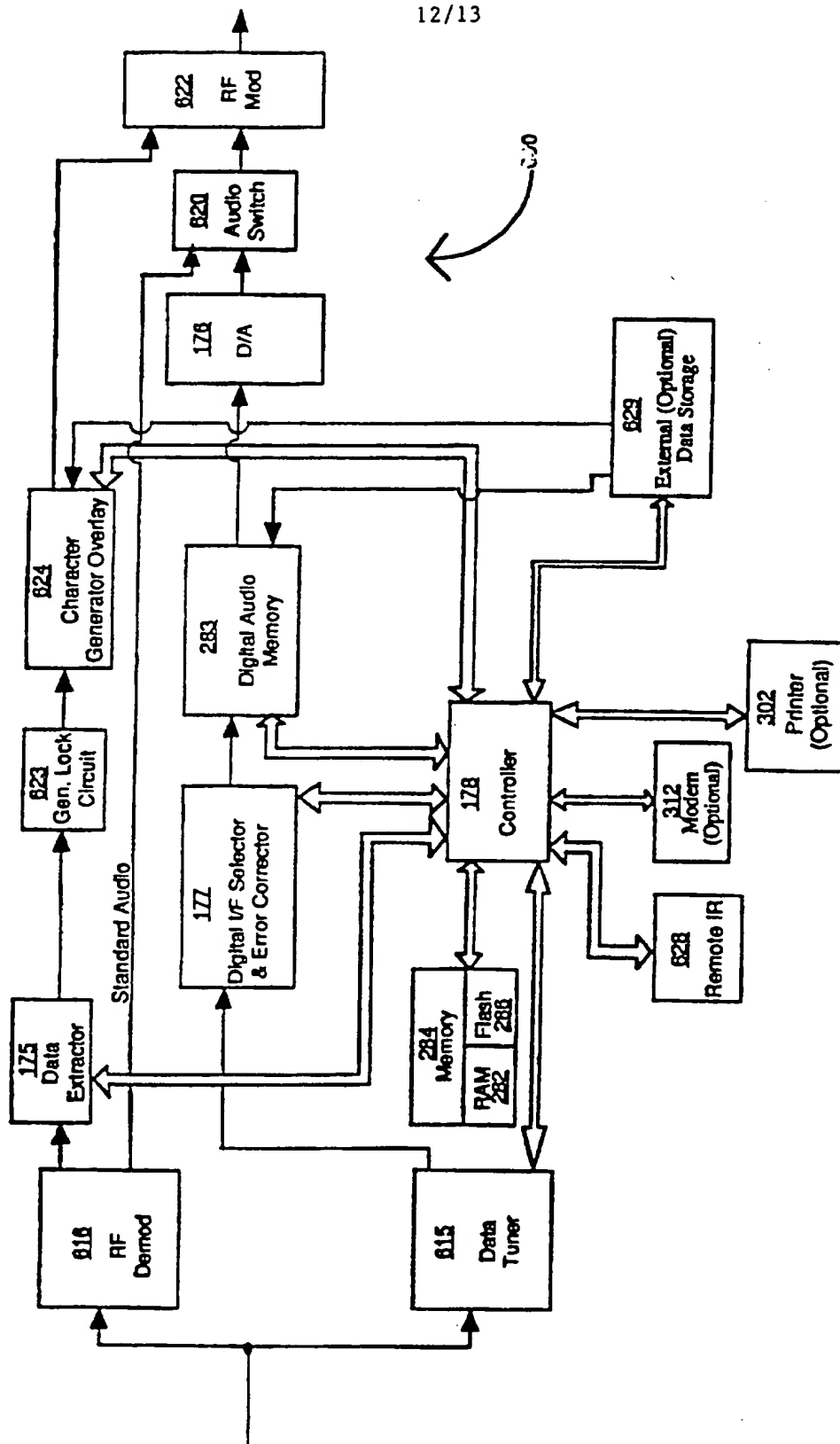


figure 12

13/13

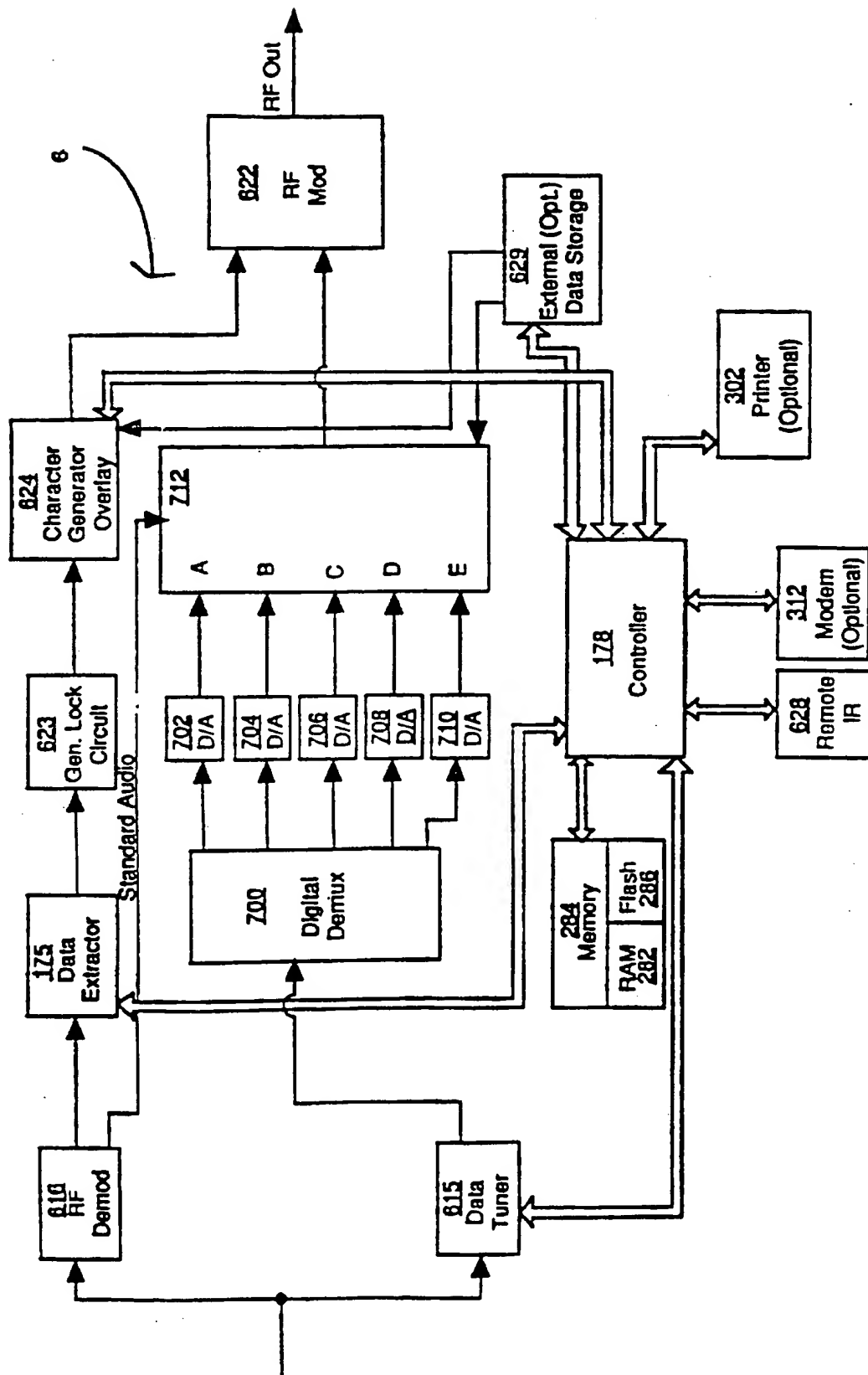


Figure 13

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US97/02062**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) : G06T 13/00

US CL : Please See Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 395/806, 807, 762, 173, 174, 327, 328; 434/307R, 308; 364/514A; 348/6, 7, 8

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,454,722 A (HOLLAND ET AL) 03 October 1995, col.2, lines 30-45, col.3, lines 28-36, col.4, line 40, col.5, lines 7-29; FIG.4	1
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Y		2-6
Y,P	US 5,541,662 A (ADAMS ET AL) 30 July 1996, col.2, line 59, col.4, lines 5-46, col.7, line 36, col.8, lines 51 to col.9, line 24.	2-6
A,P	US 5,557,724 A (SAMPAT ET AL) 17 September 1996.	1-6
A	US 5,033,969 A (KAMIMURA) 23 July 1991.	1-6
A	US 5,109,482 A (BOHRMAN) 28 April 1992.	1-6
A	US 5,388,197 A (RAYNER) 07 February 1995.	1-6

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:	*T	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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*O* document referring to an oral disclosure, use, exhibition or other means		
*P* document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

15 APRIL 1997

Date of mailing of the international search report

02 JUN 1997

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International application No.  
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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,467,288 A (FASCIANO ET AL) 14 November 1995.	1-6
A	US 5,261,820 A (SLYE ET AL) 16 November 1993.	1-6
A	US 5,455,910 A (JOHNSON ET AL) 03 October 1995.	1-6

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US97/02062

## A. CLASSIFICATION OF SUBJECT MATTER:

US CL :

395/806, 807, 762, 173, 174, 327, 328; 434/307R, 308; 364/514A; 348/6, 7, 8